Month.	Middle Loup.		North Loup.		Niobrara.	
	Flow in cubic feet per second.	Length of record.	Flow in cubic feet per second.	Length of record.	Flow in cubic feet per second.	Length of record.
		Years.		*Years.*		*Years.*
February					998	1
March					1,260	2
April	1,450	4	1,382	4	937	2
May	1,159	4	1,145	5	798	2
June	1,471	5	1,336	5	716	2
July	1,206	5	999	5	860	2
August	962	4	1,048	5	748	2
September	979	5	887	5	644	2
October	1,072	5	997	5	715	2
November	1,015	2	1,165	2	766	2
December					708	2

Conclusions.—An exceedingly large amount of the water in a heavy rain is absorbed by the sandy soil. This raises the water table, which conforms quite closely to the contour lines of the country for a time. A leveling process begins immediately by the water passing from the higher to the lower places along the slope of the water table. The rapidity of movement depends upon the "head" or steepness of the grade, and the texture of the soil.

The surface of the water in the marshes and lakes of the region indicates the elevation of the water table at that place. The rise and fall of the water in a lake will depend upon the relation which the supply of water, flowing to it down the slope of the water table from the higher elevations in the high lands bears to the loss, by evaporation from the surface of the lake and the flow on down the water table to the rivers. This flow from the lake may be in part on the surface at an outlet, or, as in this region, mainly, in some cases entirely, through the soil by slow percolation.

The movement of the ground water is slow, even in this permeable soil. The great sand-filled basin acts as a natural reservoir, more perfectly than a lake, because of the less evaporation from a surface of sand than of water and the slow flow toward the outlet.

In discussing the amount of ground water Mr. G. W. Rafter[3] divides the year into three periods; the storage period, including December to May; the growing period, June to August, when evaporation and absorption are most noticeable, and ground water tends to become lower; the replenishing period, September to November, when the demands on ground water are less, and it tends to return to normal height.

The record of water movement in the streams of this district seems to indicate that September is the month of least run-off, followed by an increase in October and November. The replenishing period may begin a little later than the time selected by Mr. Rafter, or it may become apparent in the springs and lakes in the interior earlier than it shows in the rivers.

In the article on "The disposition of rainfall in the basin of the Chagres" in the MONTHLY WEATHER REVIEW for February, 1904, p. 64, Table 7 shows that the heaviest rainfall occurs in July, while the greatest outflow due to ground water occurs in November, or four months later. This, with the slow movement of ground water through a sandy soil, as determined by Mr. C. S. Slichter,[4] seems to justify the suggestion that the heavy rainfall of early summer, absorbed on the hills, would percolate through the soil and reach the lower levels from four to six months later.

It would seem that the increased water reported might be explained by the slow percolation of the water from the heavy rainfall of May, June, and July, combined with the decreased evaporation due to lower temperature, and the smaller demands of vegetation; in fact, to the general law of increase in ground water in this the replenishing period. Local conditions of soil and climate emphasize this increase, making it more noticeable than in most places.

[3] Water Supply and Irrigation Papers of the United States Geological Survey, No. 80, p. 17. [4] Water Supply and Irrigation Papers, No. 67, United States Geological Survey, p. 27.

AUTHORITIES.

Geological structure.—Dr. G. E. Condra, associate professor of geology, University of Nebraska, and Professional Papers, No. 17. United States Geological Survey.

Evaporation.—Table from Monthy Report, Nebraska Section of Climate and Crop Service, United States Weather Bureau, for November, 1896.

Run-off.—Tables furnished by Prof. O. V. P. Stout, professor of civil engineering, University of Nebraska.

THE TEMPERATURE OF THE AIR ABOVE BERLIN.

FROM OCTOBER 1, 1902, TO DECEMBER 31, 1903, AS SHOWN BY THE DAILY ASCENTS EXECUTED AT THE AERONAUTICAL OBSERVATORY OF THE ROYAL METEOROLOGICAL INSTITUTE OF PRUSSIA.

By PROF. DR. RICHARD ASSMANN, Director of the Observatory.

There are four methods employed by modern aeronautics for scientific purposes:

1. *Ascents of free balloons*, carrying one or more observers. After the famous voyages of James Glaisher, in the years 1862–1866, free ascensions were seriously taken up again in 1891 at Berlin, and since then executed in large number with improved instruments (especially Assmann's aspirated psychrometer) up to the greatest height ever reached (10,800 meters, Berson and Süring on July 31, 1901).[1]

2. *Ascents of smaller balloons carrying self-registering instruments*, after the example of Hermite and Besançon at Paris, called "ballons-sondes," a method tested above all by Teisserenc de Bort at Paris by hundreds of ascents. Instead of balloons of 40 to 100 cubic meters of silk or paper, as employed elsewhere, the Aeronautical Observatory at Berlin makes use of small elastic rubber balloons holding but 2 or 3 cubic meters, which, increasing in volume with the height, ascend with increasing velocity and finally burst, without reaching an equilibrium, and a parachute brings the apparatus safely to the ground. An ascent up to 20,000 meters takes but an hour's time or little more, and so does the descent; thus the rubber balloon hardly ever covers a distance of more than 50 to 70 kilometers in its flight.

3. *Lifting of registering instruments by means of kites.*

* * * * * * *

4. In case of the wind being too weak to lift kites (below 5 or 6 meters per second) the *kite-balloon of Sigsfeld-Parseval* (capacity 68 cubic meters of hydrogen) is used and enables us to reach heights up to 2500 meters.

The Aeronautical Observatory of the Royal Meteorological Institute of Prussia, established in the year 1899 near the shooting camp of Tegel in very modest dimensions, avails itself of all the four methods above mentioned. In spite of its unfavorable situation amid extensive forests, and the perils and hindrances resulting from the vicinity of Berlin with its electric street car lines, as well as the neighborhood of the military grounds (shooting camp and barracks of the balloon division) since August, 1902, there have been made daily ascents with kites or kite-balloons without any regard to the weather. The results thereof have been regularly published through the medium of the Berlin Weather Bureau, in the Official Gazette of the same day and in several of the more important evening papers of the metropolis, as well as in the daily weather charts of the Deutsche Seewarte at Hamburg and of the Berlin Weather Bureau.

The regular ascents are made in the mornings; the publica-

[1] The four ascensions made by Hammond in 1885 from Philadelphia also gave excellent results with the sling psychrometer.—ED.

tion of the results in the charts makes it necessary to get through with the experiments by 12 and with the readings by 12:30 p. m. But ascents are made besides at other times, and on the days of the international ascents generally the whole night is being worked through. The readings are given for fixed intervals of height; the published data are air temperature, relative humidity, direction and velocity of wind for the base (40 meters above sea level) and for 200, 500, 1000, 1500 meters, etc.; a few words about anomalies in the vertical distribution of those elements and the limits of the cloud strata are added.

In the publication of the higher ascents some of the above-given intervals are omitted for want of space.

The publication in the Official Gazette runs as follows:

"Readings at the Aeronautical Observatory of the Royal Meteorological Institute published by the Berlin Weather Bureau.

Kite ascent of December 4, 1903, 8:30 to 11 o'clock a. m.

Height above sea level.	40 meters.	500 meters.	1000 meters.	2000 meters.	3000 meters.	3540 meters.
Temperature (C.)	—4.8	— 2.7	— 5.4	— 6.2	—11.8	—14.1
Relative humidity, per cent.	86	76	70	24	1	1
Direction of wind	se.	s.	s.	ssw.	ssw.	ssw.
Velocity of wind, meters per second	4.2	10.0	11.0	14.0	17.2	16.0

Cloudless. — The temperature increased from the ground up to 500 meters, and again from — 6.1 to — 5.2 C. between 1075 and 1600 meters."

To avoid a misrepresentation of the true vertical distribution of the temperature in the lower strata, caused by the rapid diurnal change to which the air temperature near the ground is subject in the morning hours, there is given for the base (40 meters) the temperature of the moment corresponding to that when the reading for the next interval of height (200 or 500 meters) is taken.

A graphic exhibit is founded on these readings and has been published regularly in the meteorological monthly, Das Wetter. [Figs. 1 and 2 are selected from the fifteen months given in the author's original pamphlet.—ED.]

The horizontal lines represent the heights for intervals of 100 meters, the light verticals are the limits of consecutive days. The heavier verticals correspond to the heights reached and the time of the ascents, the temperature at the different heights being represented as strictly simultaneous, although this, in fact, is not and naturally can not be the case. Still, in view of the comparatively short duration of the ascents when at the greater elevations, this inexactitude is but a trifling one, considering the small effect of the daily range at those heights. Equal temperatures were joined by isothermal lines, drawn for each 2° C., the intervening isotherms being added when necessary. The regular actual readings are represented by full isotherms, interpolated or extrapolated values by dotted lines. Additional observations taken by means of free or self-registering balloons are represented by dotted verticals up to a limit of 5500 meters shown by the size of the diagram. The lower and also the upper surfaces of clouds, where attained, are indicated by a $\underline{W}$ (lower) or $\overline{W}$ (upper surface) (W = Wolken, German for clouds) and occasionally by $\widetilde{cu}$ (cumuli).

The diagram represents the air temperature above Berlin during a period of fifteen months (October 1, 1902, until December 31, 1903); it appears to be so far the first and unique of its sort.[2] It shows only in its first three months a few lacunæ, caused by intervening Sundays and holidays; since 1903, these days have also been comprised in the regular work of the observatory. It establishes a clear picture of the change of temperature from day to day at different heights, and demonstrates the occasionally quite enormous oscillations therein. Likewise it demonstrates the unexpectedly frequent formation of thermal belts and inversions in their intensity and duration, as well as the bursting in of cold or hot "waves." It may be added that the daily range of temperature at the base has not been taken into account, since this would often have led to an illegible accumulation of the isothermal lines.

In order to facilitate the study of the distribution and change of temperature, all values lying above the freezing point have been pointed out in the plates by a light hachure, the limit thereof corresponding to the isotherm of 0° C. This isotherm will be found at an elevation of some 2200 meters on the 1st of October, 1902, but at 450 meters on the 2d, and on the ground on October 4, though the temperature was above the freezing point up to 550 meters. The cold wave or current which had descended from above and reached the ground on the 4th still prevails on the 6th at 500 meters, the air has grown warmer above this and beneath it; the 0° isotherm rises on the 7th to 2700 meters and sinks until the 20th in a series of oscillations to 1200, when it rapidly soars to 2600 meters, quickly to descend again to 1250 meters until the 22d. Until the 25th it rises more slowly to 2000 meters, sinks until the 28th to 1200, to wind the month up by two rapid oscillations between 2700 and 1050 meters, with some thermal discontinuities in the lower strata. Such are to be seen more particularlly in the first part of November, forming as it were "islands" of colder or warmer air, the freezing point line keeping high in the meantime (2800 to 2000 meters).

On November 14 there commences a frost period on the ground, while it yet continues to be warmer at 500 to 1000 meters. The prolonged period of frost, holding until December 15, shows only two breaks, from the 21st until the 27th, and on the 29th of November, when the 0° isotherm ascends to 1000 meters; but on December 12 there already appears in the higher state a decided warm wave, with temperatures above 0° (up to + 4° and more), while on the ground there are found 8° of frost. The warm wave reaches the ground on the 16th. A similar process is seen on December 22 and 23, with analogous formation of strata. Until January 12 the 0° line remains comparatively high (reaching 2500 meters), though with repeated considerable oscillations, but it then sinks to the ground to remain there until the 24th. On the 19th and 20th we find, between 1000 and 1500 meters, a pronounced inversion, minus 10° below and 0° above. An extraordinary rise of temperature at higher levels follows from the 24th until the 27th (+ 8° at 1500 meters!), the 0° line soars up to 3100 meters, and this again is followed by rapid cooling off, formation of thermal strata (February 1–10th), and cold waves on the 14–17th. From the 18th to the 19th the 0° line ascends from the ground to 2500 meters; at a height of 1400 meters there was a temperature of —12° on the 16th and one of + 6° on the 20th. The further course of our line until March 5 shows rapid and considerable oscillations, between 500 and 2500 meters, after which it slowly descends to the ground, touching it for the last time in the season on the 11th and 13th. Until March 23 it again keeps rising, accompanied by manifold thermal changes, and attains 2750 meters; a cold wave brings it down again on April 2–6 to 500 meters. On the 4th of April the isothermal lines below 0° are bent up rapidly and very steeply, but the 0° line does not take part in this to any degree. With numerous short changes this latter keeps comparatively low until April 21, from 200 to 700 meters, and ascends, after a rapid oscillation on the 22d–25th, until the end of the month, slowly but continuously, to attain, on May 3 and 4, 3200 meters. The "cold saints" of May 10–13, and again the 19th, show a fall to 1300 and 900 meters; the 15th and 16th an interesting inversion at 2000–2600 meters. From May 19 there

[2] See an earlier analogous diagram by L. Teisserenc de Bort in the Paris Comptes Rendus, August, 1899, and Monthly Weather Review, September, 1899.—ED.

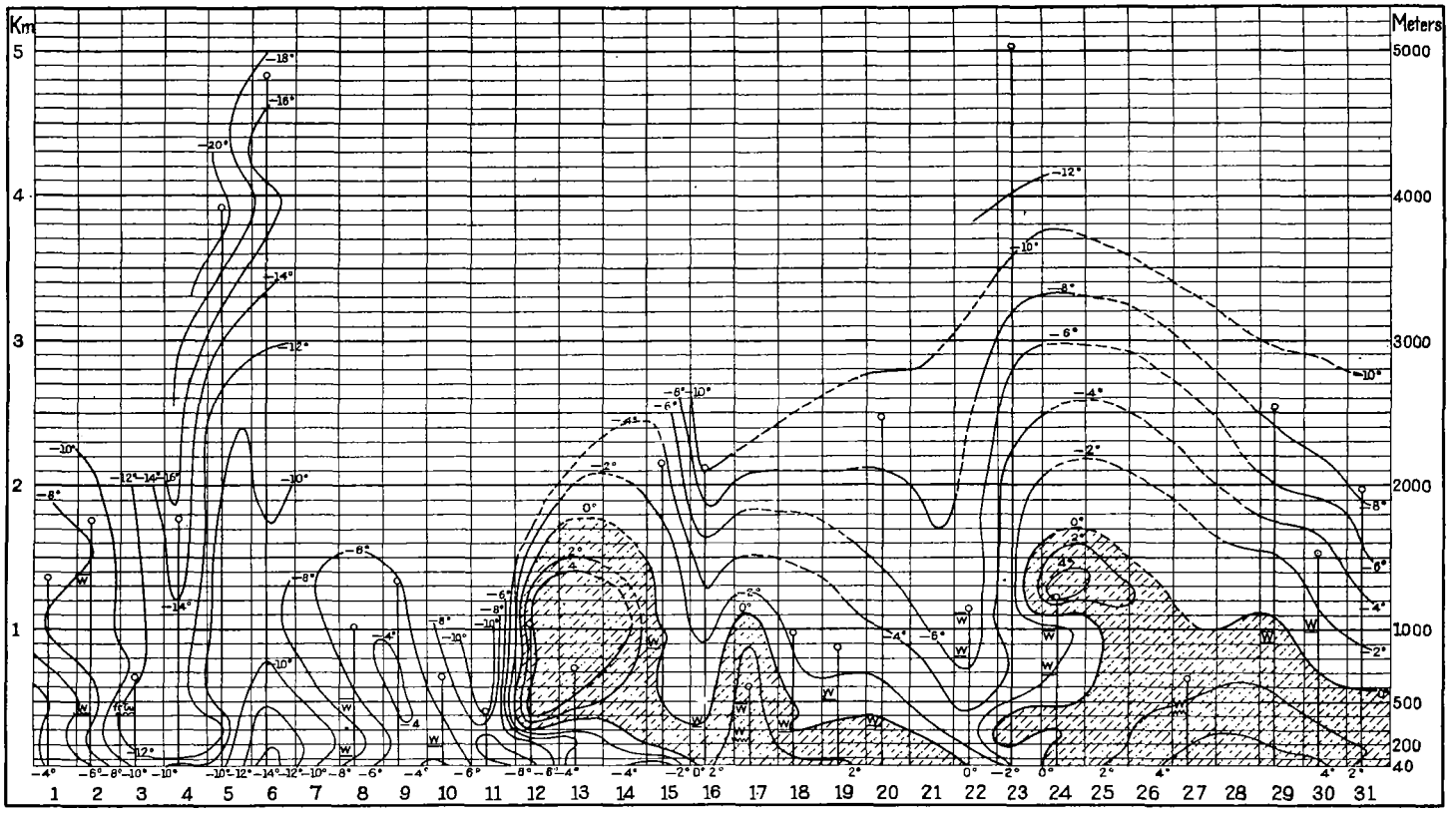

FIG. 1.

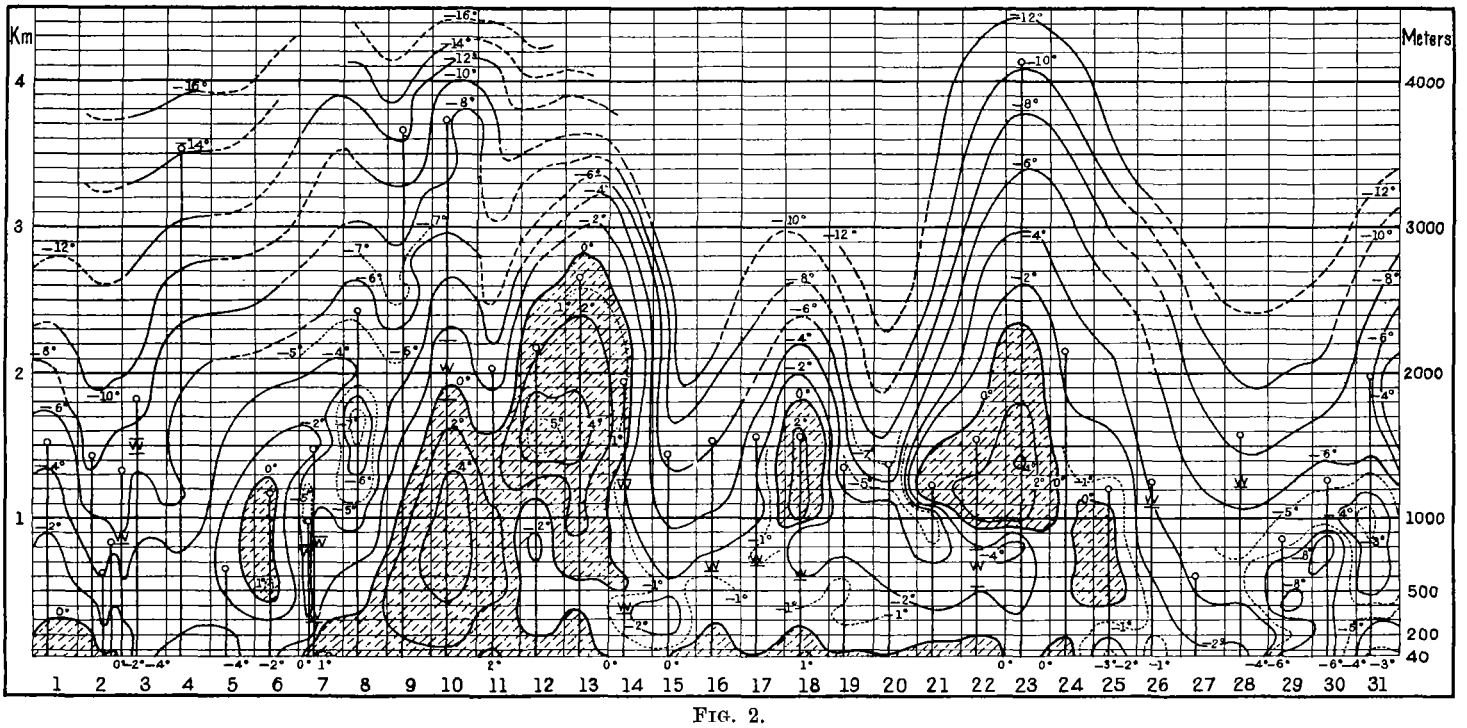

FIG. 2.

begins a considerable rise, attaining 3200 meters, followed, on June 3, by a redescending to 2250 meters. In June the mean elevation of the 0° line keeps high, between 3500 and 2200, and likewise in July and August, showing now larger shifts of height, between 2000 and 3000 meters, in nearly regular ten-daily periods. After a sudden descent of cold air down to 1500 meters, on August 30 there follows an extraordinary rise of the 0° line, reaching its annual extreme on September 3, with **5600** meters, which again was followed by a similarly rapid fall to 2800 meters by the 8th and to 1150 meters by the 12th. After that came considerable rise, to 3500 meters—18th until 20th—and up to 4000 meters on the month's last day, followed by a quick descent until the 3d of October, and a slow rise to 2800 by the 9th. With a series of considerable

oscillations between 2900 and 200 meters, combined with frequent inversions, our line sinks by the end of November and beginning of December to the ground. In December, 1903, there prevails a formation of warm strata up to 2000 meters, except on the days of 7–11th.

In presenting this first essay of a continuous study of temperature in the free atmosphere to our colleagues and to all friends of scientific aeronautics, we can not forbear to remark that it has been the result of hard work, done in all sorts of wind and weather, the execution of the ascents remaining chiefly in the hands of Professor Berson and Dr. Elias, besides the director and all the other members of the observatory.

NOTES AND EXTRACTS.

PLANETARY METEOROLOGY.

The following letter is an interesting illustration of the extent to which astrology still survives in the minds of those who have not kept up with the progress of civilization and education.

SAN DIEGO, CAL., *April 18, 1904.*

WILLIS L. MOORE,
Chief of Weather Bureau, Washington, D. C.

I beg to ask if it is contrary to your rules to allow inquiries and suggestions from the public if they do not become too frequent and embarrassing. Our weather at San Diego for some years past has been quite uncertain, due, as I assert, to the planetary changes and atmosphere. This year, or rather from last August up to February of this year, 1904, we have had more prolonged easterly winds than before in my experience of twenty years in San Diego County. As a result, the public are becoming more interested in astrological forecasts, and have been for the last few years. Having a large circle of friends who often inquire of me about the weather as I understand it from the moon phases, conjunctions, wind, etc., I have ventured to approach our Weather Bureau official a few times in the most respectful way, by way of inquiry, with a view to confirm or otherwise prevailing indications of coming changes, remarking that so many of the moon changes were close to noon, when I have been abruptly met with the remark from the forecast official, "We do not take any stock in such stuff as that." In conclusion, allow me to say while it is difficult to prognosticate weather in San Diego except by the instruments thirty-six hours ahead, there are numbers of farmers here who in the last few years have made more accurate forecasts based on astrology, moon changes, and unsettled, erratic wind currents than the Bureau of San Diego, and as a result many persons here are looking to Los Angeles. San Diego citizens are turning to Los Angeles Weather Bureau.

Yours, very respectfully,
(Signed) BENJAMIN JUDKINS.

Born June 20, 3 p. m., 1846. Sign Gemini; moon in Taurus; sun in conjunction with Mercury in the end of Gemini in △ to Saturn; R in beginning of Pisces; moon in Taurus at conjunction; Venus close star to Mars in Cancer; M. C. node 11° ascending M. 1°.

In connection with the above evidence of the continued existence of believers in astrology, we notice extracts from the San Diego newspapers lamenting the fact that southern California had no rain in October, November, and December, and no prospect of rain during January, although the local weather prophets, and even astrologers, living at a distance had promised considerable rain for the winter season. The editor of the San Diego Times says:

It failed to materialize, and we are thrown upon the Weather Bureau again with added experience in discounting old time signs as interpreted by that wonderful array of weather-wise men who annually find their way into print to demonstrate what they can not predict about the weather.

It certainly is a matter of surprise that there should be so many sensible men foolhardy enough to risk their reputation by attempting to make long-range weather forecasts when there is a reasonable certainty that they will thereby simply make themselves the laughing stock of the community.

What can the motive be, if not a mere desire for local notoriety? Surely a cautious man would make many private predictions and make sure of having a large percentage of verifications before beginning to publish. But these astrologers seem to keep no records, or at least ignore them, since every attempt to verify their work shows its utter unreliability.

Are they not monomaniacs—men of unbalanced minds, paradoxers, or possibly even quacks and fakirs?

One of the most persistent of the planetary forecasters says:

The papers that publish my forecasts are not edited by fools and the millions of families that read them are not so ignorant that they do not know what they want. The fact that they pay for my work is evidence that they closely examine it and have found it useful.

We think this enthusiast is mistaken. Newspaper editors are always willing to pay for whatever increases the popularity of their newspapers. They publish interesting matter that will, they think, catch the attention of the reader simply because it is news. They would like to have the reputation of publishing nothing but what is correct, reliable, and true, but this is almost an impossibility in many cases. So they publish nearly everything that comes handy, and leave it for the discreet reader to make his own selection.

Perhaps one million persons see the astrological forecasts, but do one hundred thousand read them with any care or attention, or find them useful? A forecast is useful only when a man actually makes some use of it, and really profits by its use. Our experience is that of the millions who read the daily forecasts of the Weather Bureau some rarely make any use of them, others do make use of them. Only a relatively small percentage of readers know how to put these forecasts to use or are able to alter personal business arrangements to suit the predicted weather. They ordinarily glance at the prediction. If it says "rain," they may pick up an umbrella which they would otherwise have neglected; if it says "fair weather," they may save themselves the trouble of carrying an umbrella. Only a small percentage of the Weather Bureau predictions relate to storms or extremely severe weather changes, such as would necessitate the rearranging of plans of work for the day. It must be very much the same way with the long-range astrological forecasts. Only those can be really useful that foretell such important matters as demand attention and foretell them in such a definite way that we know when and where they will occur. Unfortunately, the astrologer rarely or never does this, and, therefore, we think that his forecasts can not be really useful to the community. They, however, do serve as topics of conversation, to keep the subject of astrology always before the public, to stimulate credulity in the minds of those who admire and wonder at the wisdom of the learned seer. We remember very well that certain newspapers in Cincinnati supported the feeble beginnings of our work in forecasting by the assurance that the subject was one of such popular interest that they were quite willing to pay a certain sum annually (although I believe they were never called on to do it). Whether our predictions were verified or not was less important than the fact that we were about to make the trial, and everyone wished to see what we said.

A few years later in Washington we were approached by some of the brokers, operators, and gamblers who shove the prices of grain and stocks up and down, and were assured that a high price would be paid for special indications about the weather, as it was now forming a very important additional basis for their gambling operations. We refused to have anything to do with such use of the information in our possession, but we have lately noticed that some of the men who are now engaged in long-range forecasting for the daily newspapers are also going into the business of forecasting the crops and even the prices of crops. From this point of view, they and their colleagues "on 'change" may possibly think that their planetary forecasts are "useful," since whatever helps one to make a fortune or a living is useful to him. The Weather Bureau can not altogether prevent the misuse of its daily forecasts, but by making them free to the whole public